BOTANICAL GAZETTE

MARCH, 1894.

Some rare Myxomycetes of central New York, with notes on the germination of Enteridium Rozeanum.

ELIAS J. DURAND.

WITH PLATES IX AND X.

The lake region of New York state is famous as a botanical collecting ground. In the Cayuga region alone 1,278 species of phanerogams have been catalogued. Although flowering plants are so abundant, ferns, mosses, algæ and fungi occur in great profusion. The Myxomycetes form no exception to this rule. The multitude of gorges and ravines, which render the region of Ithaca picturesque and unique among our lake valleys, presents an environment very favorable to the development of these singular organisms.

A large number of Myxomycetes have been collected near Ithaca at various times, but especially during the last two years. Many interesting species have been found, several of which will be noted in this paper.

I. Rare Myxomycetes.

ARCYRIA MACROSPORA Peck, 34th Rep. of the N. Y. State Mus. Nat. Hist., 1881, p. 43. — This species illustrates the fact, that the characters of species of Myxomycetes depend largely upon the power of the objective used in their study. Markings which appear to be of a certain character, when viewed with a one-fifth inch objective, are found to be entirely different when examined with a one-twelfth inch oil immersion objective. For example, the spores of *Trichia fallax* have long been described as warted, but under the one-twelfth inch objective, the epispore is found to be delicately reticulated. Dr. Peck evidently based his description of *Arcyria macrospora* upon observations made with the lower

powers of the microscope. Under the highest powers, the characters appear to be so different as to be scarcely recognizable. I, therefore, redescribe the species on this basis.

The description is drawn from material in the Cornell University Herbarium, collected at Ithaca in 1879, and sent to Dr. Peck, in 1880, for determination. It is labeled "*Arcyria macrospora* Peck, n. sp.," and is referred to by him in his description (l. c.).

Plants crowded or gregarious, stipitate, collected on a common hypothallus. Sporangia globose, or shortly elliptical, deep brick-red in color, with a shade of brown. Dehiscence circumscissile. Hypothallus yellowish-brown, shining, forming a broad thin sheet, on which the sporangia stand. The stipe equals the sporangium in length, and is dark brown, almost black in color. The base of the sporangium after dehiscence forms a shallow cup, in the center of which the capillitium is loosely attached, much as in *A. adnata*. The capillitium is dense, with the spore-mass deep brick-red in color when fresh, fading to cinnamon brown with age. The capillitial threads are about 6μ in diameter, and are quite closely combined into a net. The markings consist of broad raised bands, closely combined in a reticulate manner. The bands are so thick, that they appear as coarse warts when seen in cross section along the edge of the thread. The spores are minutely verrucose, and very large, being 10–13μ in diameter. Plate IX, figs. 1, 3; plate X, fig. 9.

This is a very distinct species, being strikingly different from all of our other species of *Arcyria*. Externally the appearance is much like that presented by specimens of *A. adnata*, but the internal characters of the species are recognizable at a glance. The large size and peculiar markings of the capillitial threads, together with the large warted spores, are peculiarities which cannot be overlooked.

The description is much the same as that of *A. inermis* Racib. Myx. Cracov., 1885, as given in Massee's Monograph. If the species be identical, Peck's name has the priority by four years.

This species seems as yet to be quite rare. The only localities known at present are: Copake, Columbia Co.; Grafton, Rensselaer Co., and Ithaca, Tompkins Co.; all in New York. The Copake and Grafton localities are given on the authority of Dr. C. H. Peck.

The plant was noticed at Ithaca first in 1879, when it was collected from a hemlock log, in Fall creek ravine. On April 13, 1893, I collected specimens from the same station. In June, 1893, a few specimens were found in Cascadilla ravine also, on a hemlock stump. I suspect that the species has been overlooked on account of its external resemblance to *A. punicea* and *A. adnata*.

CRIBRARIA PURPUREA Schrader, Nov. Pl. Gen., p. 8, 1797.—Plants usually scattered. The hypothallus is small but distinct, formed only of the thick, expanded foot of the stipe. Stem rather elongated, usually two or three times as long as the diameter of the sporangium, dark purple. Sporangium large, globose, reddish purple. The calyculus occupies rather less than one-half of the sporangium, and is usually ribbed. The thickened portions of the sporangium form an irregular net-work. The nodes are irregular in form, but are somewhat elongated, and filled with purple granules. The connecting threads are nearly colorless, with numerous free branches, in the form of short projections, or of threads which are not connected with any node. The spores are purple in mass, but colorless by transmitted light. They are 5–6.5μ in diameter, smooth.

This is a fine species, very distinct from *C. elegans* B. & C., with which it is perhaps confused. It is the largest and by far the most beautiful species of the whole genus. It usually covers considerable areas on the log where it occurs. When the spores are dispersed they lodge on the mosses and rotten wood, when the deep purple color is very conspicuous, so that it may be seen from a considerable distance.

The species is by no means common, and is usually found in cool or mountainous regions. Dr. Peck writes me that he has found it in the Adirondack and Catskill mountains, and at Sand Lake, New York. He has received it from Canada, (*Macoun*) and from Maine (*Harvey*). At Ithaca three stations are known: Six-mile creek, Fall creek, and Coy glen. At these places the plants grow on logs, the individuals standing indifferently on mosses or the rotten wood. Plate IX, figs. 2, 4, 5.

TRICHIA ERECTA Rex, Proc. Phil. Acad. Sci., 1890, p. 193.—A small quantity of this rare myxomycete was collected from a rotten log, in Coy glen, near Ithaca, April 15, 1893. The specimens correspond very well to the descrip-

tion by Dr. Rex, and are almost exactly similar to the material distributed as no. 2,496 of the North American Fungi.

Dr. Rex has given an excellent account of the species in the proceedings cited above. The only station known at that time was in the Adirondack mountains. Whether additional ones have been discovered since, I am not able to state. This is a fine species, distinguished among the Trichias by the stipitate checkered sporangia, the spinulose cylindrical elaters, and the warted spores.

II. Germination of Enteridium Rozeanum.

ENTERIDIUM ROZEANUM (Rost.) Wing.—It is my purpose in this part to present some of the results of studies upon the swarm-cells of Enteridium Rozeanum. These investigations were undertaken during the winter of 1893, as a part of some special work upon the group of organisms to which this plant belongs. The material from which the cultures were made was collected from an old log on Fall creek flats, an extensive swamp at the head of Cayuga Lake. The plants were found about the middle of October, 1892, and put away in a dry place. In December, the germination of the spores of a large number of species collected during the fall was tried, but those of Enteridium were the only ones which showed any signs of germination. I considered myself fortunate to have succeeded even so much, for the difficulties in the way of germinating the spores of Myxomycetes are well known.

As is the case with many fungi, myxomycete spores require a period of rest before germination will take place. The length of this period seems to vary, not only according to the species, but also according to the conditions under which the spores are kept. Fully as important a consideration is the medium in which the germination is attempted.

The method of culture which I employed was the well-known moist chamber formed from several thicknesses of filter paper, wet with distilled water, sustaining a cover-glass, upon which, in a hanging drop of water, the spores were sown. The best temperature for germination seems to be about 70° F.

When about to germinate, the spore absorbs water, the protoplasm swells, rupturing the wall of the spore along one side. Through the V-shaped opening thus made the nucleated protoplasm flows or streams out in a mass (plate IX, figs. 6, 7, 8). After leaving the spore the protoplasm, or, as

it is now called, the swarm-cell, becomes spherical, and undergoes a short period of rest (plate X, fig. 10). The swarm-cells at this time measure about 9μ in diameter. This diameter is found to be, on an average, about one and one-half times that of the original spore.

After remaining in the spherical resting state for a short but variable time, the swarm-cell assumes a new form. The body elongates, becoming cylindrical or fusiform, measuring about 12μ × 2–3μ. At one end a cilium is produced which is long and lash-like, three to five times as long as the long diameter of the cell body. Often two cilia are produced,—*one at each end* (plate X, fig. 12). This biciliate condition seems to be peculiar to Enteridium Rozeanum, so far as I have been able to ascertain. De Bary mentions the fact that two cilia are occasionally produced, but his figures represent both cilia at the same end.

By the lashing of the cilium the swarm-cell is made to move rapidly through the water, executing what De Bary calls the "hopping movement." I cannot see the appropriateness of this term. It appeals to me more as an oscillatory or undulatory motion. Through the rapid lashing of the cilium, the body oscillates as if hung on a pivot at the center. The cell meanwhile is in constant amoeboid movement, so that its form is constantly changing, to a limited extent. The form of the body does not change as a result of the motion of the cilium, but by virtue of some force within the body of the cell itself. The vibration seems to be in a horizontal plane, and not the double conical or figure-of-eight movement possessed by many bacteria. In the case of the biciliate swarm-cells, the kind of movement does not differ materially from that of those with one cilium. The oscillatory movement is the same, but its rapidity is much increased. In many cases it is almost impossible to follow a vigorous cell in its vibrations, so rapidly does it move.

The general shape of the uniciliate swarm-cell is fusiform, the cilium being at the smaller, pointed end. In almost every instance, the uniciliate swarm-cells of Enteridium Rozeanum possess a curious appendage at the larger, posterior end (plate X, fig. 11). This consists of a spherical mass of protoplasm, with a diameter slightly less than the short diameter of the cell body. This appendage contains a vacuole, and is joined to the cell body by a short thread of protoplasm. In

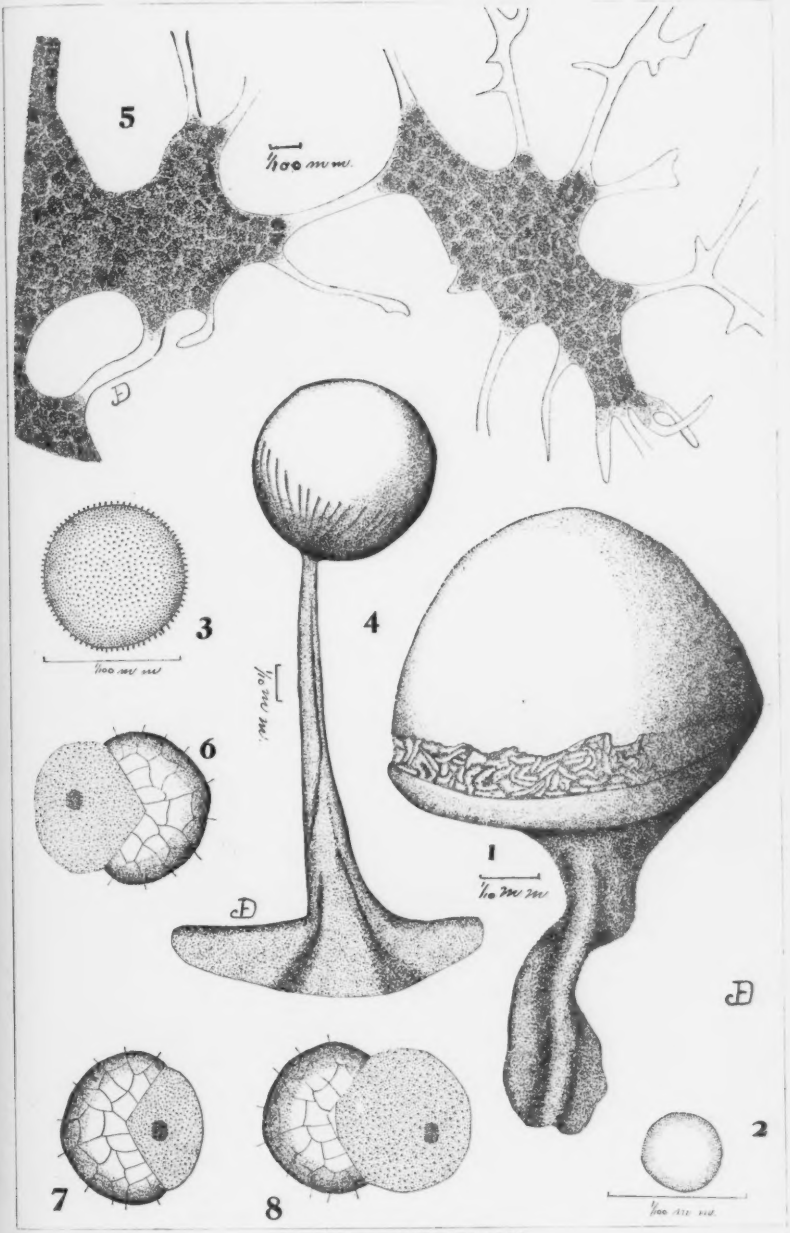
no instance have I observed this separating from the cell body. I did not once observe the creeping movement of the swarm-cell described by De Bary and Lister. When this movement is begun, the oscillatory movement is said to cease, while the cell moves slowly along the glass, with the cilium directed forward.

In the course of its amoeboid movement the cell assumes many forms. Sometimes it is nearly straight. Again it will be bent double, so that the anterior and posterior ends are nearly in contact. At other times protrusions or pseudopodia appear in parts of the cell, so that the body assumes almost numberless outlines.

The swarm-cells, after remaining two or three days in the ciliated state, absorb their cilia and pass into an amoeboid stage, when they are nearly spherical in form. Amoeboid movement takes place constantly, although but slowly and to a slight degree (plate X, figs. 13, 14, 15). It is at this time that division takes place. This process I now outline as observed in the case of a single swarm-cell. When first noticed the cell appeared a little longer than broad. While under observation, it lengthened slightly, and a constriction appeared on each side in the middle of its length. This constriction gradually deepened, as if a cord, tied around the cell, were being drawn so as to cut it in two. As the process continued the constriction became deeper and deeper on each side, until finally the two parts were held together by only a narrow thread of protoplasm. In time, this also disappeared, and the two parts became distinct and separated from each other. Each was then spherical in form. The time occupied in this division was about thirty seconds.

After undergoing division for a time, the spherical swarm-cells collected into small groups or colonies. In these cells, which are closely packed together, the thin layer of ectoplasm occupying a little less than one-fourth of the radius, appears clear and transparent. Within, the granular endoplasm contains the nucleus and vacuoles (plate X, fig. 16). This differentiation of the protoplasm is not apparent in the swarm-cells under other conditions. The cells retain their individuality for a time, but are soon seen to be blending together into a common mass, the young plasmodium (plate X, fig. 17).

The plasmodia are about 24μ in diameter, whereas the spherical swarm-cells are only about 9μ. Whether the nuclei



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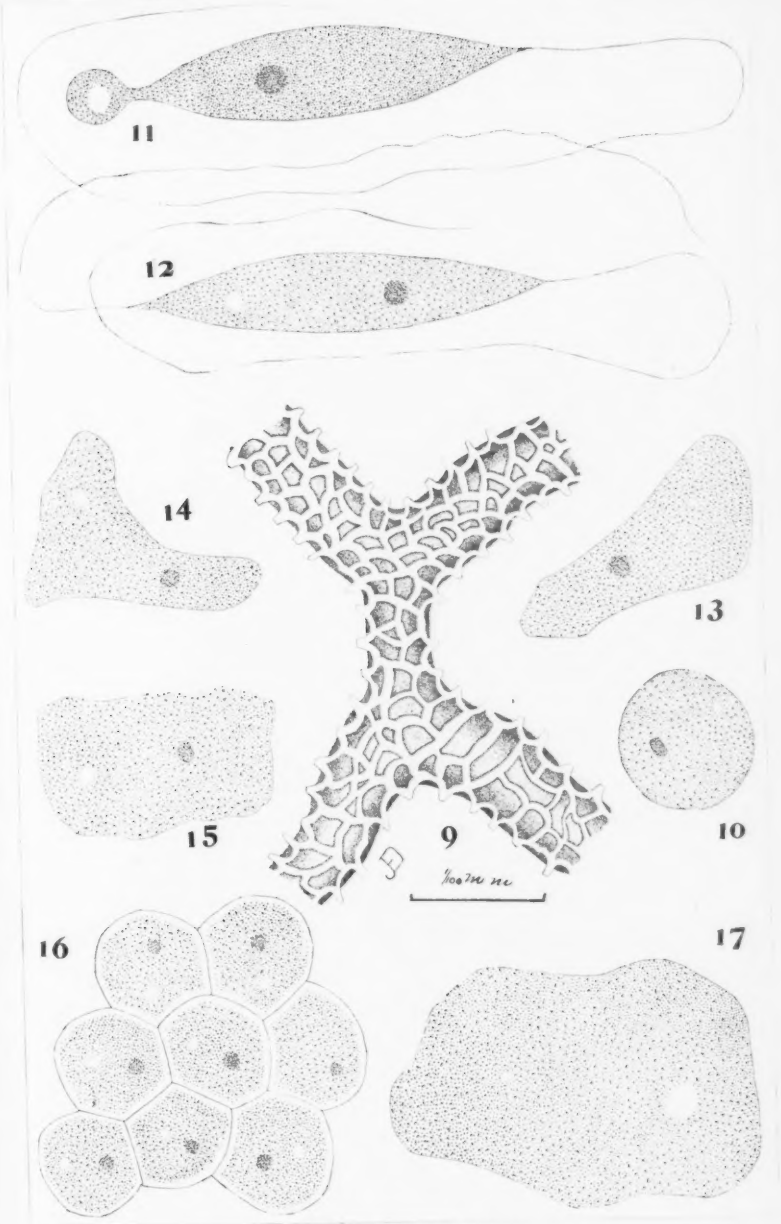

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of the cells remain distinct in the young plasmodium, I was not able to determine. But in the plasmodium there is only one contractile vacuole, while each of the component cells contained one. The movements of the mass are distinctly amoeboid, and the protoplasmic currents can be clearly seen in the plasmodium as it moves slowly from place to place. The expansion of the contractile vacuole is very gradual until it attains its full size. After remaining expanded for a moment it suddenly disappears entirely. The time occupied from one disappearance to another is from forty to sixty seconds.

In the movement of the young plasmodium the protoplasm flows in a definite direction for a time, until a large pseudopod is formed. The rest of the plasmodium then flows into the pseudo pod. The movement is that of the whole mass in a definite direction. The young plasmodium meanwhile is irregular in outline, owing to the putting out of small pseudopods from all sides of the mass.

I was unable to induce the development of this species beyond the young plasmodial stage. Many different methods of culture were tried, with many different media, but all without success. I was particularly desirous of obtaining a mature plasmodium of this species, in order to study the formation of the æthalium. As is well known, the arrangement of sporangia in the æthalium is very complicated, and the mode of their formation and union is at present unknown. Perhaps some one, more fortunate than myself, may be able to complete these observations, and work out this interesting structure.

My acknowledgments are due to Prof. G. F. Atkinson for suggestions and kindly advice in carrying out this study.

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EXPLANATION OF PLATES IX AND X.—The scale where known is indicated with each figure. Figures 6–8, and 10–17 are drawn without reference to a scale; in these figures the unbroken lines surrounding the protoplasm are to be understood as indicating boundaries only, and in no case cell walls.

Fig. 1. sporangium of *Arcyria macrospora*.—Fig. 2, spore of *Cribraria purpurea*.—Fig. 3, spore of *Arcyria macrospora*.—Fig. 4, sporangium of *Cribraria purpurea*.—Fig. 5, portion of sporangial wall of same.—Figs. 6–8, germinating spores of *Enteridium Rozeanum*.—Fig. 9, portion of capillitium of *Arcyria macrospora*.—Fig. 10, spherical swarm-cell of *Enteridium*.—Fig. 11, ciliated swarm-cell with appendage.—Fig. 12, biciliated swarm-cell.—Figs. 13–15, amœboid swarm-cells.—Fig. 16, coalescing swarm-cells.—Fig. 17, young plasmodium.

Contributions from the Cryptogamic Laboratory of Harvard University. XXIII.[1]

Notes on the life history of a blue-green motile cell.

BRADLEY MOORE DAVIS.

WITH PLATE XI.

In view of certain opinions that have been expressed by some botanists, notably Hansgirg, but which most botanists have not generally accepted, that there exist motile conditions of certain members of the MYXOPHYCEÆ (CYANOPHYCEÆ), the writer was much pleased when last November he happened to meet with a unicellular blue-green motile organism and was able to trace its life history.

These blue-green motile cells were first noticed while examining some material collected from a pool in the salt marshes of the Charles river, Cambridge. They appeared in such quantities in vessels holding the collections of *Beggiatoa*, *Oscillatoria*, *Melosira*, *Cladophora*, *Enteromorpha clathrata*, etc., found in the salt marshes, that they formed a scum upon the surface of the water and sides of the vessels, where they readily passed into a non-motile stage. The source of the blue-green swarmers was soon traced to colonies of bluish-green cells, that resembled colonies of Polycystis, and were found commonly adhering on the sides of marsh grass (Spartina) and other objects. The measurements of these cells were identical with those of *Polycystis pallida*, and the colonies resembled strikingly the herbarium specimens of this species.

Anton Hansgirg has been the most prominent champion of polymorphism among the Myxophyceæ. He has expressed himself as believing that species of Euglena[2] give rise to Oscillatoria filaments and certain blue-green swarmers he thinks may come from Oscillatoria filaments[3] although he has not seen their formation. Goebel[4] states that he has seen the formation of swarm spores in Merismopedia. Thus it was

[1] Prepared under the direction of Dr. W. G. Farlow.
[2] Hansgirg, Botanisches Centralblatt **23**: 232. 1885.
[3] Hansgirg, ibid. p. 230.
[4] Goebel, Outlines of Class. and Sp. Morph. of Plants (Engl. trans.) 22. 1887.

with considerable interest that the writer undertook the study of the form which he had found whose non-motile state so closely resembled *Polycystis pallida.*

Motile stage.

The motile cells were to be found at all times in small numbers. There was no time of day when they appeared in quantities, as is the habit of zoospores of members of the Chlorophyceæ, although they exhibited the same phenomena of collecting on the sides of the vessel nearest the light. When confined in a Van Tieghem cell they swarm about for a day or two, finally coming to rest at the edge of the drop of water.

The cells (plate XI, fig. 1) are broadly elliptical in outline, from 8–10μ long and 5–6μ wide. One end is slighly truncate in shape and contains a slight depression into which the pair of cilia are inserted. The cilia are not the same length, the longer being about as long as the cell is wide and the other somewhat shorter. They are so placed, and the figure illustrates this point, that the longest cilium is nearest to the longest axis of the cell.

Inside the cell are from six to ten disc-shaped bodies arranged around the periphery of the cell. These bodies are not pyrenoids, nor are they amorphous albuminous matter, for they are readily destroyed by a dilute potassic hydrate solution after long treatment in mercuric chloride in absolute alcohol. For this reason it seems as though these bodies are true chromatophores, although the blue-green tint is not always confined to them. Sometimes the blue-green color seems to fill almost the entire cell, only the end which bears the cilia being hyaline.

Near the middle of the cell on the periphery are one or often two bright red pigment spots: when two they are always placed near together, sometimes almost touching. The presence of the two pigment spots in one individual did not seem to indicate that conjugation had taken place, for such specimens were not necessarily larger in size and no specimen was ever observed with four cilia.

At the opposite end of the cell from the cilia there is usually to be found a light colored area that probably marks the position of the nucleus, which was demonstrated to be present in the non-motile cells.

The motion of the motile cells through the water is quick and sometimes they dart to one side in a manner that suggests at once the motion of certain infusoria. They come to rest slowly, moving occasionally from side to side some time after they seem to have settled down. While they sometimes spin around on the ciliated end just before they settle down, they do not attach themselves in a perpendicular position but rest on one side. The length of time these cells remain in the motile condition, and the character of their movements, forms a striking contrast to the motile phases of other algæ, such as Cladophora, Draparnaldia, Ulva, etc., whose zoospores settle down within a few hours to develop a new individual.

Non-motile stage.

The motile cells when they came to rest in a Van Tieghem cell, did not divide for two or three days and after that only at intervals of two or three days. The division consists of a longitudinal splitting of the cell into a pair of similar cells and hence in the colonies they tend to show a pretty regular arrangement in groups of twos and fours. They are about the same size as the motile cells but inclined to be a little shorter and somewhat broader in their proportions. That there is a common gelatinous envelope surrounding young colonies is often clearly shown by the quantities of bacteria that swarm at a fixed distance from the cells (plate XI, fig. 2). This gelatinous envelope is not a marked character however and in large colonies it is quite insignificant (plate XI, fig. 3), although it is not difficult to prove its existence with proper stains.

The chromatophores, in the non-motile cells, are not arranged in any regular manner and sometimes the entire cell appears of an almost uniform blue-green tint. The chromatophores vary in size but are usually discoid in shape, (plate XI, fig. 4). They may be brought out with great distinctness in cells after treatment with absolute alcohol, and appear perfectly homogeneous.

One or two, and rarely three, pigment spots are to be found near the middle of the cells on the periphery. Their color however is not so bright as in the motile stage but inclined to be a brownish-red.

A well defined nucleus (plate XI, fig. 5) can easily be demonstrated when specimens, well fixed and hardened, are

treated with dilute potassic hydrate solution to destroy the chromatophores and then stained with eosin.

In several instances, while examining under the microscope the colonies scraped from the marsh grass, single cells were observed to slip out from the colony and swim away and these were identical with the blue-green motile cells.

Taxonomy.

The presence of a well defined nucleus, pigment spots and chromatophores clearly showed that this form was not a member of the Myxophyceæ as the group is defined by most botanists.

Of late there has been considerable discussion on the inner structure of the cells of Myxophyceæ, particularly in respect to the possible occurrence of nuclei and chromatophores. Almost all the investigators in this field of research agree in saying that there never exists a nucleus in the usual sense of the word; that, if present at all, it is in the form of some central body of very indefinite outline, or scattered through the cell in the shape of small granules which react with stains in a manner similar to the chromatin bodies in the nuclei of higher plants. The nucleus in the present form is perfectly well defined and contains a distinct nucleolus. In regard to the presence of chromatophores in the cells of Myxophyceæ there is less unanimity of opinion among recent writers. Several investigators, Hieronymus, Zukal, and others, believe that chromatophores exist; but other investigators, Zacharias in particular, have not been able to find them. The chromatophore of Hieronymus is present as a network just under the cell wall and is only made apparent by special treatment. No investigator appears to have seen bodies as definitely organized and outlined as the chromatophores in the cells of the form that has just been described. For a general review of the literature on this subject the reader is referred to a paper by Flahault in the Revue gén. de Botanique **5**: 181. 1893.

Blue-green motile cells have been known for a long time. Ehrenberg[5] in 1838 published an account of three species under the genera *Cryptomonas* and *Cryptoglena* and since then very little has been added to our systematic knowledge of these forms. The genus *Cryptoglena* was distinguished from *Cryptomonas* by Ehrenberg because of its pigment spot, and

[5] Ehrenberg, Die Infusionsthierchen als vollkommene Organismen. 1838.

therefore the present form clearly belongs to *Cryptoglena*, as defined by Ehrenberg, but no species of Ehrenberg agrees with it in measurement nor does it resemble any of Ehrenberg's figures. Moreover, none of Ehrenberg's species were marine.

Under the name *Cryptomonas polymorpha*, Perty[6] has included all the blue-green forms of Ehrenberg as well as some grass-green forms, but his uniting so many various forms under one name does not seem to be warranted and has not been generally accepted by recent writers. Stein[7] gives an account of the structure of a form he calls *Cryptomonas ovata* Ehrenb.; but, as Hansgirg[8] has shown, his form cannot be the same as Ehrenberg's *Cryptomonas ovata* for the latter is grass-green and has only one cilium, while Stein's form is blue-green and has two cilia. Cienkowsky,[9] previous to Stein's publication, had minutely described a form, calling it *Cryptomonas ovata*, which is evidently much the same form as Stein's *Cryptomonas ovata*. More recently Dangeard[10] has given a description of *Cryptomonas ovata* and his seems also to be the same as that of Cienkowsky and Stein. This form, studied by Dangeard, Stein and Cienkowsky, is very different from that which I have found. Their species has no pigment spot, no bodies corresponding to the chromatophores in my form, it is much larger and the cell shows a degree of complication far greater than is found in the one here described.

Dangeard[11] has also described a new blue-green motile cell, *Cryptomonas cyana*, which is very small (3–4μ long), and quite recently[12] he mentions having observed a marine *Cryptomonas* (*C. marina*), but the description is too short to enable me to judge whether or not it is similar to the present organ. sm. A species that closely resembles my form in measurements, has been described by Hansgirg[13] as *Chroomonas Nordstedtii*, but this species differs in having no pigment spots and in the shape of the chromatophore which is lamina-like with pyrenoids 3μ wide.

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[6] Perty, Zur Kennt. kleinster Lebensf. nach Bau. Funk. System. etc., 1852.

[7] Stein, Der Organismus der Infusionthiere. III Abtheilung, I Hälfte. *pl. 19, fig. 26.* 1878.

[8] Hansgirg, Bot. Centralblatt. **24:** 342. 1885.

[9] Cienkowsky, Ueber Palmellaceen und einige Flagellaten. Archiv f. mikr. Anat. **6:** 424. *pl. 23.* 1870.

[10] Dangeard, Contribution a l'étude des organismes inférieurs. Le Botaniste II.—:47. 1890.

[11] Dangeard, l. c., p. 54.

[12] Dangeard, Note sur un Cryptomonas marin. Le Botaniste III.—:—1892.

[13] Hansgirg, Bot. Centralblatt **23:** 230. 1885.—**24:** 376. 1885.

As the presence of pigment spots, character of the chromatophores and general simplicity of the cell distinguish the form here described from the genus Cryptomonas as understood by Dangeard, Stein, Cienkowsky, and primarily by Ehrenberg, it has seemed best to adopt the name Cryptoglena with the character of the genus as defined by Ehrenberg, and as no described species appears to be like the present form, it seems desirable to publish its description as:

Cryptoglena Americana, sp. nov.—Motile cells broadly elliptical, 8–10μ long, 5–6μ wide: cell contents blue-green with 6–10 disc-shaped chromatophores arranged around the periphery: one or two bright red pigment spots placed on the periphery near the middle of the cell: one end hyaline, slightly truncate, with a depression from which arise a pair of cilia of unequal length, the longer about as long as the cell is wide.

Non-motile cells slightly shorter and somewhat broader than motile cells (7–9μ long $\times$ 6–7μ wide), arranged in groups of twos and fours in a closely packed Polycystis-like colony: almost uniformly colored, blue-green, with 6–10 disc-shaped chromatophores and one or two brownish red pigment spots near the middle of the cell at the periphery: nucleus near the middle of the cell.

Habitat: salt marshes of the Charles river, Cambridge, Mass., on stems of grass and larger algæ. Autumn.[14]

The agreement in measurements between the non-motile cells of *Cryptoglena Americana* and the cells of the American form of *Polycystis pallida*, described by Dr. Farlow,[15] is very interesting and suggests the possibility that this *Polycystis pallida* is really the non-motile condition of this species of Cryptoglena. I have had the opportunity of comparing herbarium specimens of the American *Polycystis pallida* with European specimens of the same species and they seem to be identical.

Herbarium speeimens of *Polycystis pallida* give very little evidence of a cell structure as differentiated as *Cryptoglena Americana*, but specimens of *Cryptoglena Americana* after being dried on mica for a month gave very little indication of the chromatophores and no indication of the pigment spots.

[14] The motile condition appears to be common all through the winter. It has frequently been met with since the above was written.

[15] The marine algæ of New England 28, 1879.

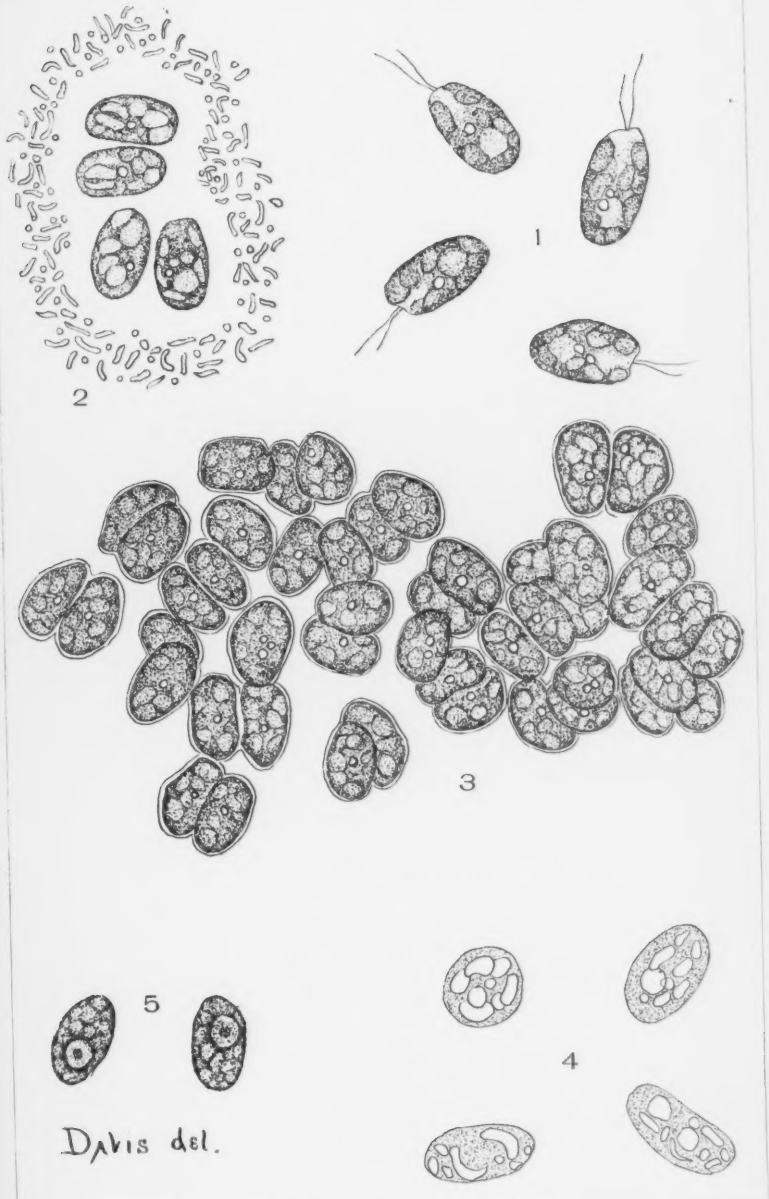
The question of a possible identity of these two forms can only be settled by an examination of fresh material of *Polycystis pallida* and it is desirable that botanists who have the opportunity of investigating this point should bear the question in mind.

Cambridge, Mass.

EXPLANATION OF PLATE XI.

All figures sketched with an Abbé camera and magnified about 750 diameters; reduced in engraving one-tenth.

Fig. 1, Motile cells, killed with Flemming's fluid.—Fig. 2, A young colony of non-motile cells; the boundary of a surrounding gelatinous envelope is marked by the swarm of bacteria.—Fig. 3, A colony of non-motile cells.—Fig. 4, Four non-motile cells after treatment with absolute alcohol, showing chromatophores.—Fig. 5, Two non-motile cells, after treatment with dilute potassic hydrate solution, and staining with eosin, showing nuclei.



DAVIS on CRYPTOGLENA AMERICANA, n. sp.

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Flowers and insects. XII.

CHARLES ROBERTSON.

CLEMATIS VIRGINIANA L.—The flower, with its horizontally expanded sepals, measures about 2^{cm} across. The flower clusters form large, white masses upon the shrubs upon which the plants climb. The flowers are dioecious. The white color and the easily accessible nectar attract numerous, mostly small, short-tongued insects. The visitors, however, are principally flies, three-fifths of the species being of this kind.

An interesting comparison may be made between this plant and *Isopyrum biternatum*, an account of which is given in the GAZETTE, **17**: 173–5. 1892. The flowers of both species are white, though the Clematis is more conspicuous, and the extent of nectar concealment is almost identical. Nevertheless, the species show a marked difference in the kinds of insects visiting them, as the following table will show:

	BEES.	OTHER HYMENOP.	SYRPHIDÆ.	TACHINIDÆ.	MUSCIDÆ.	OTHER DIPTERA.	OTHER INSECTS.	TOTAL.
Isopyrum biternatum	31	0	10	1	1	2	5	50
Clematis Virginiana	9	10	6	10	7	11	2	55

The difference is mainly a result of the time of blooming. Isopyrum, according to my observations, blooms from March 24th to May 12th, and Clematis Virginiana from July 11th to Aug. 16th. During the blooming time of the former, bees are almost as abundant as during the blooming time of the latter. Of the lower aculeate Hymenoptera I have never seen in my neighborhood more than six species during the period of Isopyrum, though they become more abundant about the time the plant goes out of bloom; but they reach their maximum during the period of Clematis Virginiana, within which time I have noted 115 species flying simultaneously.

Then Isopyrum is exposed to a tachinid fauna of only six species also, while the Clematis is exposed to thirty or more

species. The *Muscidæ* are also more abundant while Clematis Virginiana is in bloom. It seems that bees and *Syrphidæ*, therefore, are less abundant on the Clematis on account of the competition of the lower Hymenoptera and the other Diptera.

As far as I have observed in my neighborhood, this is the latest blooming of the Ranunculaceæ. By late blooming it gains the signal advantage of avoiding competition with such allies as Ranunculus, Isopyrum, Anemonella, etc., and it finds the general anthophilous insect fauna at its maximum. Its period overlaps with the periods of *C. Pitcheri* and *Anemone Virginiana*. *C. Pitcheri*, its congener, is hardly a competitor, since, as observed below, it is adapted to bumble-bees. The Anemone, being a pollen flower, also avoids competition to some extent by attracting a different set of insects.

The following insects were taken from the staminate flowers on July 27th, 28th, 30th and August 3d:

HYMENOPTERA.—*Apidae*: (1) Apis mellifica L. ☿, s.; (2) Bombus virginicus Oliv. ☿, s. and c. p.; *Andrenidae:* (3) Halictus zephyrus Sm. ♂♀, s. and c. p.; (4) H. confusus Sm. ♂♀, s. and c. p.; (5) H. stultus Cr. ♂♀, s. and c. p., the most abundant visitor; (6) H. cressonii Rob. ♂; (7) Sphecodes arvensis Pttn. ♂, s.; (8) S. confertus Say ♀, s.; (9) Prosopis affinis Sm. ♂♀, s.; *Eumenidae:* (10) Odynerus tigris Sauss., s.; (11) O. foraminatus Sauss., s.; *Crabronidae:* (12) Crabro minimus Pk., s.; (13) C. interruptus Lep., s.; (14) Oxybelus 4-notatus Say, s.; *Nyssonidae:* (15) Nysson plagiatus Cr., s.; *Sphecidae:* (16) Pelopoeus cemenrarius Dru., s.; (17) Isodontia philadelphica Lep., s.; (18) Sphex ichneumonea L., s.; *Scoliidae:* (19) Scolia bicincta F., s.

DIPTERA.—*Conopidae:* (20) Oncomyia loraria Lw., s.; *Syrphidae:* (21) Platychirus quadratus Say; (22) Allograpta obliqua Say; (23) Mesograpta marginata Say; (24) Sphaerophoria cylindrica Say; (25) Eristalis transversus Wd.; (26) Syritta pipiens L.; *Tachinidae:* (27) Exorista sp.; (28) Loewia globosa Twns.; (29) Hyalomyia purpurascens Twns.; (30) Jurinia apicifera Wlk.; (31) J. smaragdina Mcq.; (32) Micropalpus fulgens Mg.; (33) Frontina flavicauda Riley; (34) Siphona illinoensis Twns.; (35) Miltogramma argentifrons Twns.; (36) Sarcomacronychia aurifrons Twns.; *Sarcophagidae:* (37) Sarcophaga sp.; *Muscidae:* (38) Calliphora erythrocephala Mg.; (39) Graphomyia sp.; (40) Lucilia sp.; (41) L.

latifrons Schin.; (42) L. cornicina F.; (43) Compsomyia macellaria F.; (44) Musca domestica L.; *Anthomyidae:* (45) Homalomyia canicularis L.; (46) Anthomyia albicincta Fll.; (47–48) Chortophila spp.; *Sepsidae:* (49) Sepsis sp.; *M. acalyptratae:* (50–53) spp.—all sucking.

LEPIDOPTERA.—*Lycaenidae:* (54) Lycaena pseudargiolus B.-L., s.

HEMIPTERA.—*Capsidae:* (55) Lopidea media Say, s.

CLEMATIS PITCHERI Torr. and Gray.[1]—In this case we have a bumble-bee flower produced by a very simple modification. The sepals, instead of being expanded horizontally so as to admit all sorts of insects to the pollen produced in the anthers, and to the nectar secreted by the filaments, are thick and rigid and have their edges so closely approximated that bees are only admitted at the small opening formed by their separating tips.

The flower is nodding and is purplish exteriorly. It measures about 2^{cm} long and opens to the extent of 5^{mm}. The tips of the sepals are pointed and reflexed, so as to form foot-holds for the visiting bumble-bees. As observed above, nectar is secreted by the filaments. After a bee has inserted its head as far as it will go, it still needs a proboscis from 12 to 15^{mm} long to exhaust the nectar supply.

In newly opened flowers, the stigmas are so far advanced (4^{mm}) before the anthers that cross-pollination very readily occurs by the bees touching them before disturbing the pollen. Later, when the inner anthers dehisce, spontaneous self-pollination may occur by these anthers, which finally equal the stigmas, coming in contact with the latter.

I have seen the flowers visited for nectar by *Bombus vagans* Sm. ♀, and by *Volucella vesiculosa* F.

RANUNCULUS SEPTENTRIONALIS Poir.—The plant is common, growing in scattered patches in low, rich soil. At first the flowers rise 1 or 2^{dm}, the stems finally elongating so as to hold them above the surrounding grass. The spreading stems bear only a few open flowers at a time, which renders them less conspicuous, but increases the probability of cross-pollination between flowers of distinct plants.

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[1]This plant resembles *C. Viorna*, which is described and figured by Foerste in Am. Nat. **19**: 397. 1885.

The bright yellow petals expand horizontally, the flower measuring 2 or 3^{cm} across.

The flower is proterogynous. The styles elongate, holding their receptive stigmas above the anthers, which at first are all closed. The outer stamens lengthen and discharge first, the dehiscence being extrorse.

There is abundant opportunity for cross-pollination before the anthers begin to discharge. Later cross- or self-pollination may occur by insect aid. There is no doubt that self-pollination depends mainly upon the visits of insects. If, however, the stigmas remain untouched until the inner anthers discharge, spontaneous self-pollination may occur by pollen falling upon the stigmas, since the inner filaments finally lengthen so as to hold the dehiscent anthers over the stigmas. The plant was observed in bloom from April 8th to May 24th. On six days, between April 16th and May 7th, the following list of visitors was observed:

HYMENOPTERA.—*Apidæ:* (1) Synhalonia belfragei Cr. ♂, s.; (2) Ceratina tejonensis Cr. ♂, s.; (3) C. dupla Say ♂♀, s. and c. p., ab.; (4) Osmia albiventris Cr. ♂♀, s. and c. p., ab.; (5) O. conjuncta Cr. ♀, c. p.; (6) O. lignaria Say ♀, s. and c. p.; (7) O. cognata Cr. ♂, s.; *Andrenidæ*: (8) Andrena polemonii Rob. ♂♀, s. and c. p., ab.; (9) A. cressonii Rob. ♀, s. and c. p.; (10) A. ziziæ Rob. ♂, s.; (11) Augochlora labrosa Say ♀, s.; (12) A. pura Say ♀, s. and c. p., ab.; (13) Halictus 4-maculatus Rob. ♀, s.; (14) H. pectoralis Sm. ♀, s. and c. p.; (15) H. coriaceus Sm. ♀, s. and c. p.; (16) H. lerouxii Lep. ♀, s. and c. p.; (17) H. ligatus Say ♀, s. and c. p.; (18) H. fasciatus Nyl. ♀, s. and c. p.; (19) H. pilosus Sm. ♀, s. and c. p.; (20) H. obscurus Rob. ♀, s. and c. p.; (21) H. stultus Cr. ♀, s.; (22) H. zephyrus Sm. ♀, s.; (23) Sphecodes dichroa Sm. ♂, s.

DIPTERA.—*Bombylidæ:* (24) Bombylius pulchellus Lw., s., one; (25) B. fratellus Wd., s.; *Syrphidæ:* (26) Pipiza pistica Will., f. p.; (27) P. femoralis Lw., f. p.; (28) Chilosia capillata Lw., s. and f. p., ab.; (29) Melanostoma obscurum Say, s. and f. p.; (30) Syrphus ribesii L., s. and f. p.; (31) S. americanus Wd., s. and f. p.; (32) S. arcuatus Fll., f. p.; (33) Mesograpta geminata Say, f. p.; (34) Sphærophoria cylindrica Say, f. p.; *Tachinidæ:* (35) Siphona illinoensis Twns., s; *Muscidæ:* (36) Cyrtoneura sp.; *Anthomyidæ:* (37) Hydrophoria sp., s.; (38) Homalomyia sp., s; (39–40) Anthomyia spp., s.; (41–42) Chortophila sp., s.

COLEOPTERA.—*Carabidæ:* (43) Lebia viridis Say; *Coccinellidæ:* (44) Megilla maculata DeG., f. p.; *Chrysomelidæ:* (45) Diabrotica vittata F., f. p.; *Œdemeridæ:* (46) Asclera ruficollis Say, f. p.; *Anthicidæ:* (47) Corphyra terminalis Say, f. p.; *Curculionidæ:* (48–49) Centrinus spp., f. p.

LEPIDOPTERA.—*Hesperidæ:* (50) Nisoniades juvenalis F., s.; (51) N. brizo B.-L., s.; (52) Eudamus bathyllus S.-A., s.

RANUNCULUS FASCICULARIS Muhl.—This is the common early buttercup, blooming from March 24th to May 19th. The stems rise about 1^{dm}. Each plant commonly shows only one or two open flowers at a time, so that in this case pollination between distinct plants is apt to occur; but well developed plants often show several flowers, when pollination is more likely to take place between flowers of the same plant.

The flowers are bright yellow, expanding from 15 to 25^{mm}. Newly opened flowers are less widely spread. They show the indehiscent anthers crowded in a compact mass, and the stigmas surpassing them by $1–2^{mm}$. At this time, the stigmas are receptive, and I have often found them thoroughly dusted with pollen which must have come from other flowers. The flowers are therefore proterogynous and are generally cross-pollinated. In older flowers the petals are lengthened and more expanded. The stamens also lengthen and finally overtop the stigmas, the anthers nearly concealing them. At this time, if fertilization has not already taken place, spontaneous self-pollination may readily occur by the stigmas receiving pollen from the anthers which now overtop them, and often touch them, as in the preceding.

On account of its earlier blooming, its more scattered habit, and the more exposed situations in which it grows, R. fascicularis is not so abundantly visited by insects as is the case with R. septentrionalis, though it shows a very similar list.

The following visitors were observed on six days, between April 11 and May 5:

HYMENOPTERA.—*Apidæ:* (1) Apis mellifica L. ☿, s.; (2) Ceratina tejonensis Cr. ♂, s.; (3) C. dupla Say ♂♀, s., freq.; (4) Osmia albiventris Cr. ♂♀, s., freq.; (5) Nomada sayi Rob. ♂, s.; *Andrenidæ:* (6) Andrena violæ Rob. ♂, s.; (7) A. cressonii Rob. ♀, s.; (8) A. flavo-clypeata Sm. ♂, s.; (9) Halictus pectoralis Sm. ♀, s. and c. p.; (10) H. coriaceus Sm. ♀, s.; (11) H. ligatus Say ♀, s. and c. p.; (12) H. fasciatus Nyl. ♀, s. and c. p.; (13) H. pilosus Sm. ♀, s.; (14) H. confusus Sm. ♀, s.,

freq.; (15) H. pruinosus Rob. ♀, s. and c. p.; (16) H. stultus Cr. ♀, s.; (17) Augochlora pura Say ♀, s. and c. p., freq.; (18) Agapostemon radiatus Say ♀, s. and c. p., freq.

DIPTERA.—*Bombyliidæ:* (19) Bombylius fratellus Wd., s.; *Syrphidæ:* (20) Chilosia capillata Lw., s.; (21) Melanostoma mellinum L.; (22) Syrphus arcuatus Fll., s.; (23) S. americanus Wd.; (24) Mesograpta marginata Say, s. and f. p., freq.; (25) M. geminata Say, s., freq.; (26) Sphaerophoria cylindrica Say, s. and f. p.; (27) Eristalis transversus Wd., f. p.; (28) Xylota fraudulosa Lw.. s.; *Tachinidæ:* (29) Gonia frontosa Say, s., freq.; *Sarcophagidæ:* (30) Sarcophaga sp., s.; *Muscidæ:* (31) Lucilia cornicina F., s.; *Anthomyidæ:* (32) Chortophila sp., s., freq.

LEPIDOPTERA.—*Papilionidæ:* (33) Colias philodice Godt., s.

COLEOPTERA.—*Œdemeridæ:* (34) Asclera ruficollis Say, f. p.

RANUNCULUS ABORTIVUS L.[2]—Although apparently in need of a chance to pollinate its stigmas with pollen from its own stamens, as in the cases of R. fascicularis and septentrionalis, the flowers of this species do not seem to be able to effectually self-pollinate.

Newly opened flowers have receptive stigmas before the anthers dehisce and are consequently proterogynous. Soon the outer anthers begin to dehisce extrorsely and early become reflexed. At this time the central carpels are above and entirely out of reach of the anthers. Later the stamens lengthen, but then the same carpels are still removed by the elongation of the receptacle. The lower pistils, however, may receive pollen directly from the surrounding anthers, when these have dehisced.

The stems grow from 1–4^{dm} high, and bear numerous small flowers about 5–8^{mm} wide. The petals are minute, and bear nectar pits on their bases, not protected by a scale. Although the flowers are quite inconspicuous, as compared with the two preceding species, under favorable conditions they attract insects in sufficient numbers to insure cross-pollination. But it would take long and patient watching to make out a list equal to the lists of either R. septentrionalis, or fasciculatis. On the 5th of May I noted as visitors:

HYMENOPTERA.—*Andrenidae:* (1) Andrena ziziae Rob. ♂, s., freq.; (2) Halictus stultus Cr. ♀, s. and c. p.; (3) Augochlora pura Say ♀, s.

[2] See Meehan: Contributions to the Life-Histories of Plants, VII., Proc. Acad. Nat. Sci. Philad., 1892.

COLEOPTERA.—*Coccinellidae:* (4) Megilla maculata DeG., f. p.; (5) Coccinella 9-notata Hbst., s.

The three species of Ranunculus, an account of which has been given above, are in competition with one another and with other members of the genus, as well as with other members of the order, such as Isopyrum, Anemonella, Myosurus, Hydrastis, etc. In the period from the latter part of April to the middle of May, which is the maximum period of Ranunculaceæ, *Delphinium tricorne* and *Aquilegia Canadensis* are also in bloom, but they can hardly be regarded as competitors, since the former is adapted to bumble-bees and the latter to humming-birds.[3]

HYPERICUM CISTIFOLIUM Lam.—The stems grow from 3–6^{dm} high and are often collected in rather conspicuous patches. The flowers appear in many-flowered cymes, are yellow, and expand about 15^{mm}. Of the numerous stamens the inner dehisce first, rising to the centre. The flowers are homogamous, with a chance of self-pollination. The homogamy, however, does not exist as a provision for self-pollination, though under certain conditions, it may be of advantage for this purpose; but is correlated with the fact that the flowers are devoid of nectar, and are visited exclusively for pollen.

Homogamy is a common characteristic of pollen-flowers, as well as of many highly organized flowers which secrete nectar and yield abundant pollen. The fact is that dichogamy acts disadvantageously in all cases in which a numerous set of visitors come exclusively for pollen, for these visitors neglect the flowers which are in the pistillate stage.

Hypericum cistifolium depends almost exclusively on bumble-bee females and workers, which visit it to collect pollen. On seven different days I noted them thus engaged. The species were: (1) *Bombus americanorum* F. ♀☿, ab.; (2) *B. pennsylvanicus* DeG. ☿; (3) *B. separatus* Cr. ♀☿, ab. On one occasion I saw the pollen collected by *Agapostemon bicolor* Rob. ♀. The flowers bloom from June 18 to July 22.

XANTHOXYLUM AMERICANUM Mill.—The northern prickly ash blossoms in early spring, and its blooming time is of short duration, Apr. 12th to 28th. The shrubs grow in small clumps and rise from 1–2^{m}. The greenish flowers are in small umbel-like clusters and are no more conspicuous than the young leaves

[3] See Todd: Am. Nat. **14**: 668, and Trelease: ibid., 731.

with which they appear; but insect visits are secured by abundant nectar secreted by the large gynobase. The corolla forms a loose tube about 2^{mm} long, beyond the tip of which the entire length of the conniving styles is exserted. The ovaries and the gynobase each occupy about half of this tube. The elevation of the ovaries gives them the novel function of obstructing the tube and to some extent concealing the nectar, and the most convenient passages to the nectar are the intervals between them. In the staminate flowers the gynobase is developed into a more widely expanded disc, with lobes extending between the filaments. In this form the nectar is concealed by the filaments and by the rudimentary ovaries. Access to it is most convenient between the filaments. Cross-fertilization between distinct plants is secured by dioecism. In spite of the inconspicuousness of the flowers abundant insect visits are insured.

This is a good illustration of the value of nectar as an entomophilous character of flowers. The secretion of nectar is, as a rule, all that is necessary to induce insect visits to flowers in natural situations and under fairly favorable conditions, and I am in the habit of disregarding the opinion that flowers are not frequently visited by insects in all cases where I am satisfied that nectar is secreted. When nectar alone is such an effective agent in securing insect visits the fact that flowers display even the least advertisement in the way of conspicuously colored parts is conclusive proof of the extreme importance of insect aid.

The following visitors of Xanthoxylum were taken on four days, between Apr. 12th and 19th:

HYMENOPTERA.—*Apidæ:* (1) Apis mellifica L. ☿, s. and c. p., ab.; (2) Ceratina tejonensis Cr. ♂, s.; (3) Osmia lignaria Say ♂♀, s., ab.; (4) O. albiventris Cr. ♂, s., ab.; (5) Nomada luteola Lep. ♂♀, s., ab.; (6) N. maculata Cr. ♂♀, s., ab.; *Andrenidæ:* (7) Andrena sayi Rob. ♂, s., ab.; (8) A. pruni Rob. ♂♀, s., freq.; (9) A. cressonii Rob. ♂♀, s., ab.; (10) A. flavo-clypeata Sm. ♂♀, s., ab.; (11) A. rugosa Rob. ♂, s.; (12) A. mariæ Rob. ♂, s.; (13) A. claytoniæ Rob. ♂♀, s., ab.; (14) Halictus sp. ♀, s.; (15) H. gracilis Rob. ♀, s., freq.; (16) H. arcuatus Rob. ♀, s.: (17) H. lerouxii Lep. ♀, s.; (18) H. ligatus Say ♀, s.; (19) H. cressonii Rob. ♀, s.; (20) H. zephyrus Sm. ♀, s., freq.; (21) H. caeruleus Rob. ♀, s., freq.; (22) H. confusus Sm. ♀, s., freq.; (23) H. stultus Cr. ♀, s. and c. p., ab.; (24)

Augochlora pura Say ♀, s.; (25) Colletes inæqualis Say ♂♀, s., ab.

DIPTERA.—*Syrphidæ:* (26) Chrysogaster nitida Wd.; (27) Syrphus americanus Wd.; (28) Xanthogramma felix O. S.; (29) Mesograpta geminata Say; (30) Sphærophoria cylindrica Say; (31) Eristalis dimidiatus Wd.; (32) Helophilus similis Mcq.; *Tachinidae:* (33) Jurinia apicifera Wlk.; (34) Gonia exul Will., ab.; (35) G. frontosa Say, ab.; *Muscidae:* (36) Lucilia cæsar L.; (37) L. cornicina F. freq.; *Cordyluridae:* (38) Scatophaga squalida Mg.—all sucking.

LEPIDOPTERA.—*Noctuidae:* (39) Plusia simplex Gn., s.

RHUS GLABRA L. — The greenish-yellow flowers are crowded in dense terminal panicles. Each flower forms a broad, shallow cup, in the bottom of which is situated a broad, yellow, five-lobed disc, which secretes nectar. In the pistillate flower access to the disc is impeded only by the style with its three large stigmas, and by small tufts of hairs on the inner faces of the five petals. In the staminate flower the disc is somewhat concealed by the large anthers.

As far as observed this species seems to be dicœcious. In the patch of plants on which most of the insects were taken I found only pistillate flowers. I have also found patches in which all of the flowers appeared to be staminate, and in which, after the flowers fell, no fruit was to be seen, but only the naked axes of the panicles.

I have noted the flowers in bloom from June 8th to 24th. On account of the convenient nectar they are visited by numerous insects, mostly short-tongued Hymenoptera and Diptera, as shown in the following list, which contains insects noted on the flowers on three days, June 22d to 24th.

HYMENOPTERA.—*Apidae:* (1) Apis mellifica L. ☿, s., ab.; (2) Ceratina dupla Say ♀, s. and c. p.; (3) Heriades carinatum Cr. ♂♀, s. and c. p.; *Andrenidae:* (4) Andrena crataegi Rob. ♀, s.; (5) Halictus arcuatus Rob. ♀, s. and c. p., ab.; (6) H. parallelus Say ♀, s.; (7) H. lerouxii Lep. ♀, s.; (8) H. fasciatus Nyl. ♀, s.; (9) H. pilosus Sm. ♀, s. and c. p.; (10) H. pruinosus Rob. ♂♀, s.; (11) H. confusus Sm. ♂♀, s. and c. p., ab.; (12) H. zephyrus Sm. ♀, s. and c. p.; (13) H. stultus Cr. ♀, s. and c. p., ab.; (14) Augochlora pura Say ♀, s. and c. p.; (15) Agapostemon bicolor Rob. ♀, s. and c. p.; (16) A. radiatus Say ♀, s.; (17) Colletes willistonii Rob. ♂♀, s., freq.; (18)

C. eulophi Rob. ♂♀, s., freq.; (19) Prosopis affinis Sm. ♂, s. and f. p.; *Vespidae:* (20) Polistes metricus Say, s.; *Eumenidae:* (21) Odynerus anormis Say, s.; *Crabronidae:* (22) Oxybelus frontalis Rob., s.; (23) O. emarginatus Say, s.; *Mimesidae:* (24) Mimesa proxima Cr., s.; *Philanthidae:* (25) Cerceris robertsonii Fox, s., freq.: (26) C. compacta Cr., s., freq.; *Sphecidæ:* (27) Ammophila gryphus Sm., s.; (28) A. vulgaris Cr., s.; (29) Isodontia philadelphica Lep., s.; (30) Prononyx thomæ F., s.; *Pompilidae:* (31) Pompilus marginatus Say, s.; *Braconidae:* (32) Vipio robertsonii Ashm. (MS.), s.

DIPTERA.—*Empidae:* (33) Empis sp., s.; *Conopidae:* (34) Physocephala tibialis Say, s.; (35) Zodion nanellum Lw., s.; *Syrphidae:* (36) Syrphus ribesii L., s. and f. p.; (37) S. americanus Wd., s. and f. p.; (38) Mesograpta marginata Say, s. and f. p., freq.; (39) M. geminata Say, s. and f. p.; *Tachinidae:* (40) Ocyptera euchenor Wlk., s.; (41) Jurinia apicifera Wlk., s., ab.; (42) J. smaragdina Mcq., s.; (43) Belvosia bifasciata F., s.; (44) Trichophora echinomoides Twns., s.; (45) Sarcomacronychia aurifrons Twns., s.; (46) Masicera sp., s.; (47) Acroglossa hesperidarum Will., s.; *Sarcophagidae:* (48) sp., s.; (49–52) Sarcophaga spp., s.; *Muscidae:* (53) Stomoxys calcitrans L., s.; (54) Lucilia cornicina F., s.; (55) L. sylvarum Mg., s.; *Anthomyidae:* (56–57) Chortophila spp., s.

COLEOPTERA.—*Mordellidae:* (58) Mordella marginata Melsh., s.

Carlinville, Ill.

An auxanometer for the registration of growth of stems in thickness.

KATHERINE E. GOLDEN.

WITH PLATES XII AND XIII.

Description of the instrument.

The main feature of this auxanometer for measuring growth in thickness (see plate XII) is a balanced glass arm supported near one end, acting as a multiplying lever. The longer part of the arm has a bristle fastened at the end that registers the lateral movement upon one or more blackened glass rods carried round on a brass spool, the spool being revolved by a clock.

The glass arm passes through a short brass tube held between two hardened steel points. The position of the arm is varied by changing the brass Y, holding the points, which is kept in place by a set screw. The longer arm is counterbalanced by a weight suspended from the shorter arm. Close behind the steel points is a small fork; this fork presses the stem to be measured upon one side, and the glass arm upon the other. The fork is made at the end of a screw thread, to admit of movement backward and forward, to accommodate large or small stems. To keep the long glass tube straight a fine wire is stretched from one end to the other, passing over a support, thus forming a truss. These pieces of mechanism are held in place by a long wooden beam, supported on three feet placed near one end, one of which is provided with a levelling screw to admit of adjustment for plants of varying height. The spool is made to revolve by having the axis extended at one end beyond its supports to carry a grooved pulley, which is connected with a similar grooved pulley, attached to the hour hand spindle of the clock, by means of a small rubber band. The friction between the rubber and the grooved pulleys, and the uniform tension, preclude slipping.

The instrument is used by placing the stem of the plant between the fixed fork and the short arm of the glass rod. Perfect contact of the glass arm and the stem of the plant is maintained by means of a very light wire spring fastened between the beam and the glass arm (not shown in the illustration).

The distance between the point of contact with the plant and the pivot is one-fortieth of the distance from the blackened glass rod to the pivot, so that any growth of the plant is magnified forty times on the blackened rod. Thus a growth of one-thousandth of an inch will be represented by one-twenty-fifth of an inch on the blackened rod.

From the blackened glass rod a permanent record can be obtained by making a print of it on sensitized paper, from which direct measurements can be made.

The instrument was devised and made by my brother, M. J. Golden, professor of practical mechanics in Purdue University.

The following observations are given to show the work done by the apparatus.

Record of experiments.

The study of growth in length has received a great deal of attention from many physiologists, notably Sachs. He has found that there is a maximum and a minimum point of growth, and also that there are forms of growth for which no reason, as yet, has been assigned, these latter being termed "spontaneous variations." Growth in length has been studied for small as well as large plants, but in no recorded case has growth in thickness been studied upon any but large plants, and in these the measurements were made by the observer at intervals of time with some calipering instrument, thus introducing a possible error due to the personal equation. The periodicity of growth has been determined for growth in length, but has been assumed for growth in thickness, largely as a result of measurements of growth in length and as an accompaniment to it.

The amount of tension is one of the principal factors in growth, as there is little growth when the tension is low, and greatest growth when the tension is high. Kraus[1] has found in his measurements on stems of trees, that there is a maximum and a minimum point of tension, these occurring at about the same time that the maximum and minimum points of growth have been found to occur by other investigators. But he states that he has found that temperature has very little effect on tension for the ordinary variations occur between 10–30°C. In his experiments on the tension of stems his

[1] Kraus, G., Die tägliche Schwellungsperiode der Pflanzen 28.

figures show the greatest tension when the temperature was the lowest at 2 A. M., while the tension is lowest at 1 P. M. when the temperature was 2° short of the highest point it had attained in two days.

Millardet[2] has verified the statements of Kraus with respect to the periodicity of tensions, working with *Mimosa pudica*, but he has found that a rise of temperature increases the tension, while a fall of temperature diminishes it. Kraus' measurements were made upon stems of trees (maple, birch, and oak) that would not show the effect of temperature readily, while Millardet's were made upon the stem, petiole, and leaf of a plant that would easily show small differences of tension. The subject of tension in tissues is very important as each separate tissue has its own rate of growth, causing tensions to be set up in the various tissues. In measuring stems one has to determine whether an increase in the thickness is temporary, and due only to tension, or a permanent increase due to growth. If it be tension only, a decrease in thickness will follow the increase, this being caused by a contraction of the tissues.

The plants used for the following work were tomatoes and potatoes, these being good growers in thickness as well as length, and having internodes smooth, or at least free from stiff hairs. This point had to be looked after carefully so as to allow of good adjustment of the instrument. While the measurements were being made, a registering thermometer was placed near the instrument. The work was done during December and January, 1892–3, and while there were but few sunny days, the plants were under favorable conditions for growth, as the transpiration from the plants would be low, and but slight retardation of growth from light could occur; the temperature also, for the most part, was as high as it would be in the warmer months, the work having been done in a steam-heated greenhouse.

The tomato was measured first, and on Dec. 28th and 29th the record of the second registration showed that the stem was less in diameter than for the first registration, but after that each registration showed the diameter to be greater than at first. In both cases of less diameter, the temperature was very low, which might have occasioned a low tension.

[2] Millardet, A., Nouvelles recherches sur la periodicité de la tension: étude sur les mouvements periodiques et paratoniques de la sensitive, 1870.

A factor of much importance in the growth in diameter is that of temperature, the plant responding within a short period to a rise in temperature by a more rapid growth, and a slower growth following a fall in temperature. The term growth is used, but it is, of course, understood that the increase in diameter includes the tension as well, as the results of the two are not separable.

Taking the line of growth for the tomato for Jan. 1st (plate XIII), it can be seen that the growth bears a close relation to the temperature, the high temperature being followed promptly by an increased growth. The total growth for the thirty hours can be seen very readily in the line plotted.

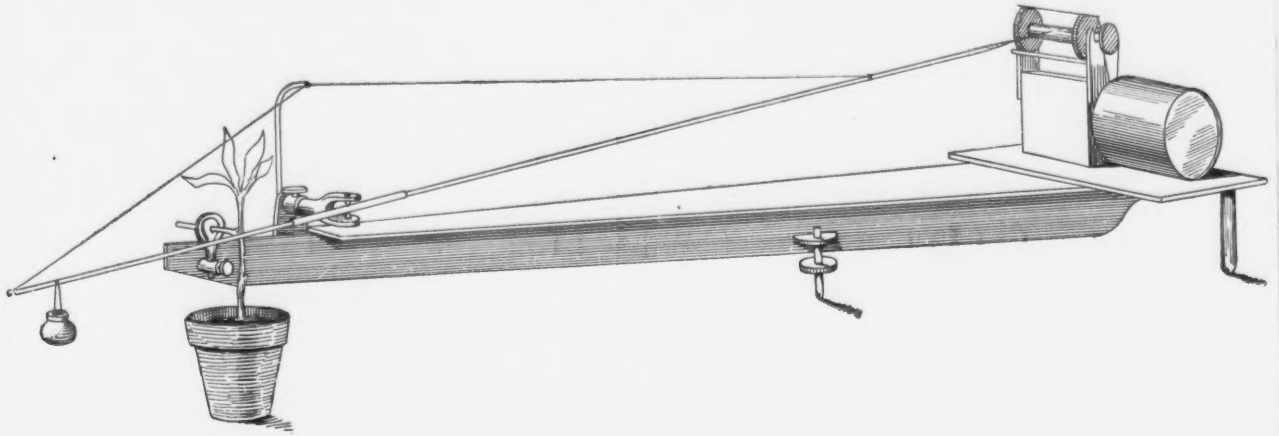
The same points are seen in the lines of growth constructed from the record of the potato for Jan. 6th (plate XIII). The potato gave a much greater growth, but aside from that the growth took place in the same manner as in the tomato. On these dates occurred the greatest growth obtained from either plant. These two have been selected as typical lines of growth for the two plants measured.

In the lines of growth obtained by taking the average amounts of growth for the different periods, the effect of temperature is not so apparent as there were no regular variations in the temperature, consequently the average line of temperature is not satisfactory in showing the relation between temperature and growth.

Examining the average line of growth for the tomato which was obtained from seven days' records, there are two points of maximum growth, one between 5 and 8 o'clock in the morning, the other between 2 and 5 o'clock in the evening. For the potato the maximum point came earlier in the morning, but was at about the same time in the evening. It was obtained from twelve days' records. The potato under approximately the same conditions gave much the more vigorous growth, but the records for both of them showed clearly that the increase in diameter was really growth, and not an expansion that would be followed by a contraction.

These observations and comparisons show what is possible by the use of the instrument. Further observations are being made in connection with an auxanometer registering growth in length, which was also devised by my brother, and is similar to the one exhibited by Dr. Arthur at the Madison meeting of the A. A. A. S.

Purdue University, La Fayette, Ind.



GOLDEN on AUXANOMETER.

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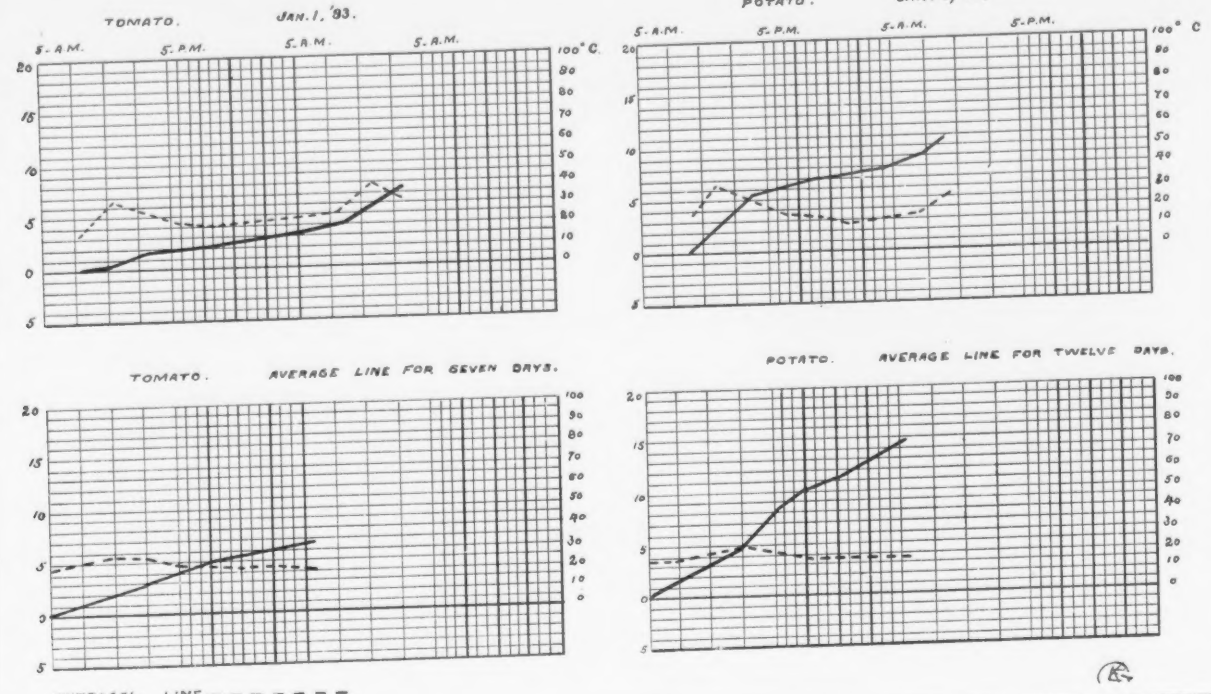
TYPICAL LINES SHOWING ONE DAYS GROWTH.



GOLDEN on AUXANOMETER

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BRIEFER ARTICLES.

Notes upon the northwestern and Rocky mountain flora. I.—In the summer of 1892 I made a very interesting trip in the northwest. The months of June, July and August were spent in Idaho. My work in that state was done in the sage brush of the southern part, in the Owyhee mountains to the southwest, and in the highlands, foothills and mountains of the central and eastern portions. I traveled by railroad to the principal points, and by stage, carriage or horseback to more distant ones. Of course I walked a good deal. I was well provided with letters of introduction, and there was seldom any difficulty in procuring company whenever desirable, which was necessarily a great part of the time. During the entire season a collection of about eleven hundred species was made, two-thirds of which were from Idaho. Many of these are interesting from the fact that they show new and unexpected localities, and many for showing variations developed under changed conditions. Some plants seem to be quite new. I have learned to regard Idaho as a meeting place of various floras. There one meets with sub-arctic plants from the north which can even be traced to Siberia, and the Cacti and other southern plants are common. There is a large desert flora and also moist thickets and meadows with a most luxuriant vegetation. The Rocky mountain plants meet those of California. In general, I should say that its vegetation is most nearly allied to that of the Pacific slope.

I wish to express my appreciation of the kindness and encouragement I received both from my friends east of the Rockies, and from those I was so fortunate as to make in the state. Had it not been for their efficient assistance I could not have reached many of the distant and less accessible regions which I visited.

Very special thanks are due to Drs. Bessey, Britton, Trelease and Coulter. They not only gave me the best sort of encouragement at the beginning of my trip, but have since extended to me the privileges of their respective herbaria and libraries. My interest and pleasure in the plants have been greatly increased by the very free use I have made of these fine opportunities, which have made my work possible. I subjoin descriptions of a few of the plants from Idaho which I have been recently studying:

Œnothera Idahoensis, n. sp.—Perennial, cespitose, acaulescent or with stout stems 20–50^{mm} long, having young buds developed at base: leaves lanceolate, 12–20^{cm}, decurrent into a petiole, which is usually about one-third of entire length; irregularly cut and incised with sharp jagged teeth usually at right angles to the very prominent midrib; scab-

rous; lower side clothed sparsely and margins, midribs and petioles very thickly with a long, soft pubescence: calyx tips united, but lobes splitting in bud, and reflexed in flower; tube 10–14^{cm} long, very slender, considerably dilated at throat, lobes 45^{mm} long, narrow; delicate rose color; smooth on inner, hairy on outer surface and on tube: petals somewhat rhomboidal, emarginate, 45–50^{mm} long, 50–60^{mm} wide in dried specimen; white and delicately veined; stamens yellow, versatile, 12–14^{mm} long: capsule ovate, not attenuate or compressed, 30^{mm} long, 10^{mm} broad, very obtusely tetragonal in cross section; not winged but having two thick, tubercular, darker ridges with a depression between them, extending vertically at each angle; corky and hairy, tuberculate: seeds in two rows, angled, not crested, minutely tuberculate.

This belongs to the cespitose group, and I think must unquestionably be called the most beautiful representative of the genus Œnothera. I found it in but one locality and within a limited area. This was on the hills beyond Boisé City, at an elevation of about 3,000^{ft}. June.

Scutellaria Footeana, n. sp.—Perennial, from filiform subterranean stolons, 6–10^{cm} high, much branched, and spreading at base; branches dark, purplish; foliage light green: entire plant including inflorescence, clothed with a minute woolly pubescence: leaves 15–25^{mm} long, entire, oblancelolate to obovate above, cuneate to almost orbicular below; all tapering to a slender petiolate base, and lower ones distinctly petioled: flowers axillary, numerous, 12–18^{mm} long, shorter than the subtending leaves: calyx in fruit a little longer than the peduncle; 6^{mm} long, 5^{mm} broad, nearly orbicular; angle and projection on back much less prominent than in most species: corolla ampliate-dilated at throat, with lower lip much broader than upper, and the two nearly equal in length; lemon yellow to dull brownish yellow at base, deepening to orange color in lobes; somewhat hairy within: nutlets acutely angled, roughly and deeply muricate upon faces and exterior surface; raised upon a much elevated slender gynobase, which appears like a prolongation of the style set upon the posterior side of a thick, scarlet cushion-like disk which bears white nectar glands upon its surface.

I find only two other species described as having their nutlets raised on a slender gynobase. These are *S. nervosa* Pursh of the Middle States, and *S. Guilielmi*, a Japanese species. Both differ from this in having nutlets surrounded by a conspicuous membranaceous wing; hence this cannot be placed in the same section with them according to Gray's definition in the Synoptical Flora.

This was found at an elevation of about 3,500^{ft} near Black Cañon, Boisé River, June 18th. I have named the plant in honor of Mrs. Mary Hallock Foote who planned, and accompanied me upon the pleasant expedition which led to its discovery.

Frasera cærulea, n. sp.—Stems slender, from a branching caudex; glabrous, or nearly so; 15–20^{cm} high, slender: leaves elongated, narrowly oblanceolate, slightly margined; the two or three cauline pairs 4–8^{cm} and the radical ones 10–16^{cm} long; those of the panicle re-

duced to linear bracts: inflorescence rather closely paniculate; pedicels as long or longer than flowers: sepals narrowly lanceolate with a conspicuous scarious margin: corolla blue; lobes ovate, acute, 6–8^{mm} long, with delicate, forked, spreading venation; glands linear, green; a little below middle, and extending nearly to base; the long villous fringe decurrent into a longitudinally adnate crown, with fringed free margins and saccate, tapering base, which has a longer and coarser fringe: a row of long setae between filaments at base: stamineal scales obovate or nearly orbicular, laciniate; longer than ovary, nearly as broad as lobes of corolla: style slender, twice the length of ovary.

Found, July 9th, on Owyhee Mountains, several miles from the De Lamar silver mine, elevation 7,000^{ft}.

Frasera montana, n. sp.—Stem rather slender, 30–90^{cm} high: leaves opposite, elongated, strongly margined; lowest 15–20^{cm} long, narrowly oblanceolate; upper ones gradually reduced in size, linear: inflorescence paniculate: pedicels two or three times as long as the flowers: sepals narrowly subulate: corolla creamy white; lobes 6–8^{mm} long, nearly twice the length of the sepals, oblong, somewhat acute; bearing the small obovate glands near base; encircling fringe rather short, longer on the decurrent pocket-like base, strongly incurved: scales between bases of filaments very small, deeply cut into two, three or more setous processes.

This species appears to be more abundant than any of the preceding ones. I think I passed it more than once when traveling through the Boisé Basin, and I collected it in two places where it was growing rather plentifully. The fruit was developing on the side of the mountain above Cooper's Warm Springs, at an elevation of about 4,500^{ft}, July 20th, and the flowers were in the height of their beauty on a rocky ledge a few miles from Pioneer, 5,000^{ft} above sea level, July 22d.

The two Fraseras above described seem to form connecting links between the last two divisions of the genus in the Synoptical Flora. Both are long pedicelled, and thus have the loose inflorescence of the former, represented by *F. albomarginata*, to which the species I call F. montana is most nearly allied, and for which it might rather easily be mistaken on a superficial examination. Both show their relationship to the last division by the crown of scales at the base of corolla. This is small in F. montana, and very large in F. cærulea. The form and position of the glands show characteristic differences.

Gilia grandiflora Dougl.—This species is quite common on the foothills around Boisé City. As usually found there it accords very well with the type description. On the higher lands I found so many variations from the type that I could scarcely reconcile myself to classing them together under the one species. The variations are in size, in branching, in character and extent of the pubescence, and in size, number and position of the flower clusters. In all these intergrading forms, there is very little or no variation in the size and form

of the light salmon-colored corolla. I describe the most extreme form as

Var. **diffusa**, n. var.—Taller, stems much more slender, 75–100^{cm} high, much branched; branches long below, very short above: leaves linear, shorter, scattered: flowers in much smaller heads, at ends of branches, and summit of stem: glandular and cellular pubescence very thick upon the calyx, bracts, and upper leaves, and sometimes the entire upper portion of plant is pubescent.—A. ISABEL MULFORD, *Herbarium Lake Forest University.*

Frost Plants.—Prof. Lester F. Ward's observations on the "Frost freaks of the dittany," in the GAZETTE for April, 1893, occasioned much interest, since the phenomena illustrate one form of the movement of water in the plant stem. I have elsewhere[1] made a lengthy review of the literature of the frost plants and take occasion to call attention to the following references which may be accessible to the readers of the GAZETTE.

Prof. Ward called my attention to the fact that the frost crystals of *Cunila* and *Helianthemum* were noted by Dr. Darlington.[2] The first observation of frost phenomena recorded is that of Stephen Elliot on the stem of *Conyza bifrons* (now *Pluchea bifrons*).[3] Sir John Herschel noticed a similar formation on the stalks of heliotrope and thistle.[4] Prof. John Leconte made an extended study of the frost crystals of *Pluchea camphorata* and *P. bifrons*, in 1848, along the coast of South Carolina and Georgia.[5] Prillieux in his investigations on freezing in intercellular spaces described the formation of radial ice plates by herbaceous plants.[6] These observations were duplicated by Trecul at the same time, and Sachs has given some matter bearing upon this point.[7] In a recent number of this journal Professor Atkinson gave a note recording the fact that these phenomena were seen by him in 1885–86,[8] while Professor Ward has found that the frost freaks of the dittany are a matter of common information in the locality in which his observations were made.[9]

It seems established that the frost phenomena occur on plants which have ceased growing, or are wholly dead; that the movement of the water upward through the stem and laterally is wholly physical and

[1] Quarterly Bulletin of the University of Minnesota. **2**: 30. 1894. Science **22**: 351. 1893.
[2] Flora Cestrica 350. 1837.
[3] Sketch of the Botany of South Carolina and Georgia. 322. 1824.
[4] London and Edinburgh Phil. Mag. III.—:110. 1833.
[5] Proc. A. A. A. S. 1850.
[6] Compt. rend. **70**: 405. 1870.
[7] Lehrbuch, 2 Aufl. 614.
[8] BOT. GAZ. **19**: 40 1894.
[9] Science **23**: 66. 1894.

that the frost plants show no especial differentiation of structure, so that it is probable that many plants, if they should pass through the death stage at a season offering the proper conditions of moisture and temperature would furnish "frost phenomena."—D. T. MacDougal, *University of Minnesota.*

Proposed seed collection of the U. S. National Herbarium.—The Department of Agriculture at Washington, D. C., has inaugurated a seed collection in connection with the U. S. National Herbarium which is intended to include seeds of all the species of plants obtainable, especially weeds and forage plants.

The seeds, when not too large, will be placed in flat-bottomed specimen tubes of two sizes, the smaller 5^{cm} long by 1.5^{cm} in diameter, the larger in vials of twice these dimensions. These tubes will be neatly labeled, systematically arranged, and placed in covered trays made of binder's-board. Fleshy fruits of native American plants will be put into similar bottles filled with preserving fluid. Authentic herbarium specimens of plants raised from the seeds represented, or of plants from which the seeds were obtained, will accompany the collection whenever possible.

Seeds of North American weeds, grasses and other forage plants are especially desired and the co-operation of all botanists is earnestly requested. A suitable exchange of seeds for herbarium material or the publications of the Division may be had in return if desired. In the case of weeds and forage plants a liter of seed is wished in order that sets may be prepared for distribution to Agricultural colleges.

In addition to the work above outlined the Division of Botany is about to undertake the testing of various seeds as to their purity and germinative power, for which purpose a laboratory will be fitted up and equipped after the most approved methods of American and European seed-control stations. In this laboratory and in the open air different physiological experiments connected with seed germination and development will be conducted. Histological studies may ultimately be made to determine the structure of the seeds of American weeds and forage plants, and, if possible, to elicit facts of taxonomic value. The entire work will be carried on with special regard to its economic importance, while the collection will be particularly useful for reference.

The matter has been placed in charge of Mr. G. H. Hicks, recently instructor in botany at the Michigan Agricultural College, to whom correspondence may be addressed.—Frederick V. Coville, *Botanist, U. S. Department of Agriculture.*

CURRENT LITERATURE.

The Letters of Asa Gray.[1]

Most of Dr. Gray's personal friends have known that his letters were being edited by his wife, and they have looked forward, with keen anticipation, to the appearance of the volumes which are before us. Nor will his most ardent lovers (for that phrase alone fitly names those who came to know him intimately) be disappointed in this collection. unless by its unavoidable fragmentariness. In his busier years the letters he wrote were necessarily largely scientific or of purely personal interest, but ithas been Mrs. Gray's endeavor "in collecting and arranging the 'Letters' from Dr. Gray's large correspondence, to show, as far as possible in his own words, his life and his occupation." "Something of the personality of the man and his many interests may be learned from these familiar letters and from even the slight notes."

We can only wish that they might reveal fully his character and personality to those who were never privileged to come under its charm, but if only "something" of it is shown, the thousands who know his name will be interested in gaining these glimpses at the life of a rarely lovable man.

The autobiography which Dr. Gray began, and from which the sketch of his early years published with a portrait in this journal (11: 1. 1887) was chiefly drawn, forms the first chapter. His early undertakings are detailed mostly in letters to Dr. and Mrs. Torrey and his father and mother, with a few to Dr. W. J. Hooker. These give an account of his studies while teaching at Utica and Hamilton college, of his life in New York with the family of Dr. and Mrs. Torrey, which was a potent influence for good, of his relations to the South Sea Exploring Expedition and to Michigan University. The third chapter consists of extracts from a very detailed and intensely interesting journal of his first visit to Europe, where he made many life-long friends. The fresh and vivacious sketches of men and things, the racy comments, the epigrammatic skits hold the attention of the reader and, before his friends, the man lives again. The remainder of the volume tells of his work from 1840–1850.

The second volume is devoted to more general correspondence which is grouped almost by decades under the titles, second journey to Europe, letters to Darwin and others, travel in Europe and America, and final journeys and work.

[1] Letters of Asa Gray, edited by Jane Loring Gray. 2 vols. crown 8 vo. pp. 838. pl. 6. Boston: Houghton, Mifflin & Co. 1893. $4.00.

It is impossible to make any comment upon these volumes except in words of unstinted praise. The selection of appropriate parts from the enormous mass of letters written by Dr. Gray has been a difficult task, no doubt; but having been done by one who was for almost forty years in loving sympathy with him, it has been accomplished with the utmost good taste, in which it is in marked contrast with some other "Letters" of great men.

Three photo-gravure portraits of Dr. Gray are given, at the ages of 31, 57 and 76. There are also three half-tone engravings, of the botanic garden house in 1852 from a drawing by Isaac Sprague, Dr. Gray in his study in 1879, and the present range of buildings in the botanic garden. Nor must we fail to commend the very copious index, too commonly neglected in such books.

The younger generation of botanists, knowing Dr. Gray chiefly through his floras, have, we fear, come to think of him as a specialist, great in his line of course, but limited in his interest to systematic botany. We, therefore, cannot urge too strongly upon such the reading of these letters, that they may become acquainted with a man not only of commanding ability as a specialist, but of wide interest in other departments and keenest appreciation of them.

Some, we are sure, will be surprised at these words:

"I am lecturing [to his college class] in a popular and general way entirely on physiological botany, and offering no encouragement to any to pursue systematic botany this year. My great point is to make physiological botany appear as it should be,—the principal branch in general education."—p. 325. (1844.)

"I finished lichens this afternoon; and have next two lectures on fungi and spontaneous generation to give. I interweave a good deal of matter, such as, on ferns, the part they played in the early times of the world, à la Brongniart. Mosses filling up lakes and pools; sphagnum, peat. Lichens, first agents in clothing rocks with soil. I have noble illustrations of rust in wheat, ergot, etc., and Sprague is now hard at work on smut, à la Bauer."—p. 330. (1845.)

These volumes will be sure to contribute to a complete understanding of him who deserves better than Robert Brown the salutation, "Botanicorum facile princeps!" For the letters to friends, though written but for the hour, have become abiding because they are a true manifestation of a lovely character whose memory will ever be fragrant.

We adopt the happy phrases of Dr. Sandys, in presenting Dr. Gray for the highest honors of Cambridge University: "This man, who has so long adorned his fair science by his labors and his life, even unto a hoary age, 'bearing,' as our poet says, 'the white blossom of a blameless life,' him, I say, we gladly crown, at least with the flowerets of praise, with this corolla of honor."

Minor Notices.

MR. G. J. PIERCE'S interesting studies on the haustoria of some phanerogamous parasites[1] have been distributed in separate form. Mr. Pierce examined the haustoria of *Cuscuta Americana* and found them morphologically lateral roots, originating endogenously and growing only at tip, developing into an organ with bi-collateral vascular bundles united with those of the stem by two strands each of tracheids and sieve tubes. These tracheid and sieve tube strands unite with corresponding parts of the bundles of the host. The haustoria occur usually in groups of not more than the number of vascular bundles in the host; and by the twining of the parasite the successive haustoria unite with different bundles of the host. Other species of Cuscuta were examined with similar results. Having thus found sieve tubes (not previously known) in the haustoria the question arose, do all phanerogamic parasites possess them, and are they thereby able to absorb the newly elaborated material from their hosts? The study of haustoria of *Viscum album*, *Brugmansia Zippelii*, *Rafflesia Patma* and *Balanophora elongata* showed that sieve tubes were absent in the green parasite, Viscum, but present in those which must, because of the absence of chlorophyll, depend wholly on their hosts for nourishment.

THE VERY LARGE private herbarium and library of Capt. John Donnell Smith, consisting of about 80,000 sheets and 1,300 volumes, has been offered to Johns Hopkins University on condition that a suitable building be prepared for their reception and provision be made for their maintenance in connection with a department for instruction and original work in botany. We long since understood that this intention was cherished by Mr. Smith, and we trust that the generous offer will stimulate the University to establish a thoroughly manned and equipped botanical department, to which Mr. Smith's accumulations may be of service. A list of the chief collections comprised in the herbarium and abbreviated titles of the works in the library are published in the J. H. U. *Circulars*, No. 109, Jan. 1894, in order that students (to whom they are already made accessible) may know what is to be found there. We hope that Mr. Smith may long continue his enthusiastic investigations and add greatly to this important herbarium.

THE SEMI-ANNUAL report (Oct. 1893) of Schimmel & Co. (Fritsche Bros.) of Leipzig and New York, who are special distillers and manufacturers of essential oils, is something more than a mere trade pamphlet. A large amount of information, both botanical and chemical,

[1] Annals of Botany 7: 291–327. *pl. 13–15.* 1893.

is given in the first 67 pages, about various essential oils. This is followed by a table of the essential oils, giving the name of the oil and the part of the plant from which it is obtained, the botanical source, the percentage yield from the raw material, with various physical and chemical observations. The publication would be of interest to botanists generally, we think. It may doubtless be obtained from the New York house on application.

In the "Wilder Quarter-Century Book," a collection of original papers dedicated to Professor Burt G. Wilder, at the close of his twenty-fifth year of service in Cornell University, by a number of his old students, appears a paper on the genus Phyllospadix, by Professor W. R. Dudley. This genus of marine Potamogetonaceæ consists of two species growing on our Pacific coast, and is believed by Prof. Dudley to be a comparatively recent offshoot of Zostera. This paper deals "with the morphology, anatomy and environment of the genus in relation to its probable origin."

A fifth paper preliminary to a monograph of the Laboulbeniaceæ, necessitated by the accumulation of new material, has been published by Dr. Roland Thaxter.[1] Thirteen new species and five new genera are characterized and a synopsis of the 23 genera and 122 species now known is given.

M. Henry L. de Vilmorin, whom many American botanists met last summer, has distributed a reprint of an article on the flowers grown in the French Riviera,[2] the beautiful sunny shores of maritime Provence. The article will be of especial interest to lovers of flowers.

Mr. B. Fink, of the Upper Iowa University, Fayette, has published a small pamphlet with the title "Blights, Orchids and Ferns at Fayette, Iowa." The first group is presented with key and descriptions; of the others but brief lists are given.

Dr. Wm. A. Setchell has distributed copies of a paper on the classification and geographical distribution of the Laminariaceæ, published in Trans. Conn. Academy 9: 333–375. 1893.

E. M. Wilcox publishes in the Jour. Cin. Soc. Nat. Hist. for July–Oct. 1893. pp. 101–4, a few brief notes on the histology of the stem of *Pontederia cordata.*

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[1] Contrib. from Crypt. Lab. Harvard Univ. XXI. New genera and species of Laboulbeniaceæ, with a synopsis of the known species. Proc. Amer. Acad. **29:** 92–111. 1893.

[2] Jour. Roy. Hort. Soc. **16:** 80–104. 1893.

OPEN LETTERS.

On a new code of nomenclature.

[In a private letter to one of the editors Dr. Kuntze asks that the following extract from it be printed in the BOTANICAL GAZETTE. It was called forth by the editor's explanation that the Madison Congress did not consider itself an international body, and that American botanists were trying to arrange certain rules of nomenclature for their own guidance, which would very likely be given as recommendations to any International Congress considering the subject.—EDS.]

I am surprised to learn from your letter that the American botanists are working out a new code of nomenclature. That will produce a schism between botanists, because the first code, that of Paris, can never be set aside or upset as Americans have partly done already. It can only be amended and augmented, and will be so maintained by conservative botanists in the future. Nomenclature in botany is more a matter of science, ancient customs and justice, than of convenience or convention; but has been treated by recent American botanists (Greene, Britton, etc.) more absolutely or nationally (that is, with no real convention for international science) than (as to their new propositions) with experience, learning and justice. I have already pointed out in my *Revisio Gen. Pl.* 3: [1] that only a few of these propositions are acceptable with the condition for future not retroactive action. Afterwards, in the last meeting of the A. A. A. S., they made more propositions, which were mostly inconsistent, as I wrote you in my last letter. Now you assert in your letter that these inconsistencies of nomenclature are mere recommendations to an international congress, but as these recommendations have been meanwhile applied practically in American check lists, etc., such as the irrational application of the 1753 starting-point of nomenclature before a competent congress agreed to it, these inconsistencies and subversions of the Paris Code are no more recommendations but revolutions against the Paris Code.

The difference between English botanists, who often work against the Paris Code, and American botanists in this matter, seems to me only that the English do it without fixed principles, while the Americans do it partly with revolutionary or wrong principles. If the decisions of national or incompetent congresses are admitted we will never reach harmony in botanical nomenclature. I trust that no competent congress would agree to a new code, and the however obtained affirmation to an aberrant codification (see Genoa), or to a new code of an incompetent congress, would be a kind of humbug. A new code, moreover, would trouble the matter, and would deprive me of my rights as emendator of the Paris Code. I hope the American botanists will avoid a schism, and avoid mistakes similar to those of the Genoa Congress.—DR. OTTO KUNTZE, *Capetown, January 21st.*

NOTES AND NEWS.

M. GASTON BONNIER has been honored with the title "Chevalier de la legion d'honneur."

DR. W. G. FARLOW is publishing in *Garden and Forest* a series of illustrated papers entitled "Notes for Mushroom-eaters."

DR. PAUL SORAUER has retired from the directorship of the Physiological Experiment Station at Proskau, and Dr. R. Aderhold has taken his place.

MR. M. S. BEBB and DR. THOS. MORONG are both in Florida on account of their health; the former at Clearwater Harbor, the latter at Jacksonville.

DR. OTTO KUNTZE has spent the winter in Capetown, "in search of health," as he writes. He intends to go over Capeland, Transvaal to Natal, and return to Germany next May.

MR. C. R. ORCUTT has begun an extensive collecting trip, in which he will be engaged until fall, devoted chiefly to the *Cactaceæ*. He is now in the Colorado Desert, from whence he will go to the Mojave Desert, and then east to Texas and to the City of Mexico.

BULLETIN 37 of the Wisconsin Experiment Station, prepared by Professor E. S. Goff, gives a very full account of the Russian thistle, with a fine illustration, among others, of a plant three feet in diameter found by Mr. L. S. Cheney, growing within a mile of the city of Madison.

J. K. HASSKARL, once joint director of the botanic garden at Buitenzorg, Java, distinguished through his introduction of the Cinchona culture there, died at Cleve on the 5th of January in moderate circumstances although he had provided his native country with a yearly revenue reckoned by millions.—*Münch. allg. Zeitung.*

AT THE MEETING of the Botanical Society of Munich on January eighth Dr. F. Brand described and illustrated by herbarium specimens the forms of the leaves of Nymphæaceæ. He finds three sorts readily distinguishable. These are the submersed leaves, the floating leaves and the aerial leaves. These are not only structurally but functionally different.

PROF. L. H. PAMMEL is the author of the following articles published in the Transactions of the Iowa Horticultural Society for 1892, recently distributed: Climate and its effects on the quality of apples. Crossing of cucurbits, Fruit rots and their prevention, Fungous diseases of the grape. The volume includes the proceedings of the Iowa Academy of Science for 1892 (113 pp.), also containing papers by Prof. Pammel.

IN *Le Botaniste* (Jan. 15), the editor, M. Dangeard, presents a paper, illustrated by four plates, on the sexual reproduction of fungi; in

which the general question of sexual reproduction in algæ and fungi is first considered, followed by an account of the results of investigation into the structure of Ustilagineæ. As to the systematic position of Ustilagineæ the author thinks that they, with the Uredineæ, form a transition group, leading from the Phycomycetes on the one hand to Basidiomycetes and Ascomycetes on the other. To this transition group the name Mesomycetes is given, already suggested by Frank.

In the *Kew Bulletin* for January the Herbarium begins the publication of a series of novelties from tropical Africa. But three volumes of Oliver's "Flora of Tropical Africa" (1868–1877) have appeared, and there has been but little time to prosecute the work further, the whole staff having been employed in determining the rapidly increasing collections and in assisting Sir Joseph Hooker in his "Flora of British India," now approaching completion. Now, however, the "Flora of Tropical Africa" is to be pushed to completion, but in order to secure priority for names the present series of descriptions of new species are to be published in the *Kew Bulletin*. This first fascicle contains twenty-two species of Apocynaceæ, by O. Stapf; ten Gentianeæ, twenty-two Boragineæ, and ten Bignoniaceæ, by J. G. Baker.

In the March number of *Harper's Monthly Magazine* there is an admirable article by W. Hamilton Gibson on "the welcomes of the flowers" to insect visitors, illustrated by many of his unrivaled sketches. Even into his diagrams he puts an artistic feeling which almost makes them pictures, while his drawings are, as every one knows, simply inimitable. After sketching the history of the knowledge of the pollination he describes charmingly, with almost no technicality, the modes of insect pollination in Salvia officinalis, Kalmia latifolia, Andromeda ligustrina, Iris versicolor, Collinsonia Canadensis, Rudbeckia hirta, Arum maculatum (after Müller) and Pogonia ophioglossoides. We predict that some of these illustrations will become classics, and doubt not copies will adorn many a chart and text-book. May their tribe increase!

Dr. Arnold Dodel-Port has begun the publication through Cæsar Schmidt, of Zürich, of a new set of wall charts entitled *Der biologische Atlas der Botanik*. Those who possess the earlier set (published between 1878 and 1883 under the title, *Anatomisch-physiologischen Atlas der Botanik*) and who know its excellences will be minded to order the new work. The sheets of the present atlas are twice the size of of the preceding, viz.: 84×120^{cm}, which will be a decided improvement. High schools and academies which do not desire the sheets dealing with the more recondite matters can purchase what they can use. For example in the first series of seven sheets, dealing with Iris sibirica, the first four, on (1) bees and flowers, (2) color and the secretion of honey, (3) structure and development of the organs of fructification, (4) structure and contents of the ripe fruit and seed, can be ordered, and the remaining three, on (5) developmental history of the ovule, (6) the processes of fertilization, (7) germination of the seed, can be left out. We are glad to commend this work and hope for it a wide sale in this country. The price is very reasonable, viz.: M. 40 for the first series of seven sheets.